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SPECIES COMPOSITION CHANGES UNDER INDIVIDUAL TREE SELECTION CUTTING IN COVE HARDWOODS

In the past, uncontrolled clearcutting on many of the good to excellent hardwood sites[1] in the Appalachians has resulted in forest stands composed of the so-called cove hardwoods, a high proportion of which are intolerant species. Characteristically these stands run heavily to yellow-poplar (*Liriodendron tulipifera* L.), northern red oak (*Quercus rubra* L.), black cherry (*Prunus serotina* Ehrh.), basswood (*Tilia americana* L. and *T. heterophylla* Vent.), white ash, (*Fraxinus americana* L.), and sugar maple (*Acer saccharum* Marsh.); and the first three species generally make up more than half the stems in the overstory. Other trees commonly found in the mixture are red maple (*A. rubrum* L.), beech (*Fagus grandifolia* Ehrh.), sweet birch (*Betula lenta* L.), white oak (*Q. alba* L.), chestnut oak (*Q. prinus* L.), hickory (*Carya* spp. Nutt.), and cucumbertree (*Magnolia acuminata* L.).

In recent years large areas of cove hardwoods have been placed under some type of forest management. In many cases the system used consists of frequent light cuttings based on individual tree selection. It would appear that such cuttings would eventually convert the stands to an all-aged condition. This raises the question: What will be the long-range effect on species composition?

[1] Site indexes 70 and upwards for oak according to Schnur, G. Luther. YIELD, STAND AND VOLUME TABLES FOR EVEN-AGED UPLAND OAK FORESTS. U. S. Dept. Agr. Tech. Bul. 560, 88 pp., illus., 1937.

Work done on our Fernow Experimental Forest near Parsons, West Virginia, points up two obvious trends: (1) the proportion of sugar maple will increase appreciably and consistently; and (2) the proportion of yellow-poplar, red oak, and black cherry will probably decrease to a point where these species are no more than minor components of the stands. The observations and experience upon which the above statements are based are discussed below.

Selection Cuttings on the Fernow

For 10 years — 15 years in two instances — tree selection has been practiced in hardwood stands on good sites on the Experimental Forest. Cutting cycles of 5 to 20 years are being followed. On some of the study areas two selection cuts have already been made. All together, the study covers 11 cutting areas totaling 211 acres. The record begins with original observations in the stands before logging and includes at least two post-cutting measurements.

At the inception of the study, in 1949, all the stands were 40- to 50-year-old second growth with a scattering of old-growth trees left when the area was logged around 1905. The overstory, except the old-growth stems, was made up predominantly of intolerant cove hardwoods. The few stems of advance reproduction (trees 1 to 5 inches d.b.h.) that were present in 1949 consisted of the very tolerant sugar maple and beech — 60 percent; the tolerant basswood and mid-tolerant sweet birch, red maple, white ash, and hickories — 25 percent; and all other species — 15 percent (table 1). These other species were mostly hophornbeam (*Ostrya virginiana* (Mill.) K. Koch.), yellow birch (*Betula alleghaniensis* Britton), oaks, elm (Ulmus spp. L.), and black gum (*Nyssa sylvatica* Marsh.).

Our tree-selection cuttings left an average post-logging basal area of about 80 square feet per acre in trees over 5 inches d.b.h. Although the stands perhaps could have been safely cut back another 10 or 15 square feet, cutting to less than about 60 square feet of basal area per acre would have invited epicormic branching with resulting log degrade, and would have retarded the board-foot growth rate.

In marking for cutting, the emphasis was on overmature and mature trees in the larger diameter classes, and on poor-risk trees and trees of poor quality potential in all merchantable size classes. No deliberate attempts were made to create openings for reproduction (although some were created incidentally): the objective was to harvest individual trees. Many foresters in the Appalachian area follow similar marking practices.

Table 1. — *Ten-year changes in species composition of understory and pole-size stems under tree-selection cutting in cove hardwoods, expressed in average numbers of stems per acre and proportions of all stems, by size classes*

Species and proportions	Stems in original stand				Stems in 10-year stand			
	1 foot tall to 1 inch d.b.h.	1 - 5 inches d.b.h.	6 inches d.b.h.	8 inches d.b.h.	1 foot tall to 1 inch d.b.h.	1 - 5 inches d.b.h.	6 inches d.b.h.	8 inches d.b.h.
Sugar maple — number	848.0	146.0	6.0	2.1	2649.0	178.0	10.5	3.5
Percent total stems	49.0	37.3	10.1	5.5	47.0	43.0	22.4	12.5
Beech — number	376.0	87.1	1.7	1.2	1102.0	73.6	2.2	1.2
Percent total stems	22.0	22.3	2.9	3.1	20.0	17.8	4.7	4.3
Sweet birch — number	25.0	41.0	8.2	3.7	230.0	29.7	6.0	3.3
Percent total stems	2.0	10.5	13.8	9.6	4.0	7.2	12.8	11.8
Red maple — number	72.0	40.6	5.2	2.3	99.0	25.4	6.7	2.8
Percent total stems	4.0	10.4	8.8	6.0	2.0	6.1	14.3	10.0
Group 1[1] — number	74.0	18.0	8.1	5.5	460.0	33.1	5.8	4.0
Percent total stems	4.0	4.6	13.7	14.4	8.0	8.0	12.5	14.4
Group 2[2] — number	332.0	58.3	30.1	23.6	1066.0	74.2	15.6	13.1
Percent total stems	19.0	14.9	50.8	61.5	19.0	17.9	33.3	47.0
Total stems	1727.0	391.0	59.3	38.4	5606.0	414.0	46.8	27.9

[1] Basswood, white ash, and hickories.

[2] All other species.

Reproduction after Cutting

A surge of reproduction always followed cutting on the study areas.[2] For example, before cutting, an average of 1,730 stems per acre 1 foot tall to 1 inch d.b.h. was found. Five years after cutting there were 7,600 stems. While sugar maple and other more or less tolerant species predominated, cutting did bring in some of the intolerant hardwoods, especially in the larger openings. After 10 years, three-fourths of the trees of miscellaneous other species (group 2 in table 1) in the 1-foot tall to 1-inch d.b.h. range were yellow-poplar and black cherry — about 800 stems. However, because of rapidly increasing overhead foliage density and/or a decrease in tolerance with age, most of these intolerant stems subsequently die or stagnate badly. Sugar maple, which is ideally adapted to selection management under a schedule of frequent light cuts, thrives. In general, tallies taken 5 and 10 years after cutting showed substantial gains in the proportion of sugar maple up to 12-inch d.b.h. sawlog size (table 2). With the passing of time the proportion of sugar maple can be expected to increase throughout all size classes.

Heavier cutting on a tree-selection basis, by opening up the canopy, would bring in and perpetuate more of the desirable intolerants such as yellow-poplar. However, selection cutting heavy enough to do this would understock the stand and, as stated previously, probably would result in lowered log quality and a reduced board-foot growth rate. In other words, individual tree selection, when carried out with due consideration for maintenance of log quality and optimum board-foot growth rates, is not appropriate for managing stands of such desirable intolerants as yellow-poplar and black cherry, or even stands of the somewhat more tolerant red oak.

Future Stands

On the basis of the Fernow study we can make some predictions about the future species composition of these stands.

We are going to have a lot more sugar maple — eventually 50 percent or more of the trees will probably be of this species. While the tabular values (tables 1 and 2) are weighted for the 11 study areas, the trends are the same on each individual area: increasing proportions of sugar maple in each diameter class during the 10-year period.

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[2] Trimble, G. R., Jr., and George Hart. AN APPRAISAL OF EARLY REPRODUCTION AFTER CUTTING IN NORTHERN APPALACHIAN HARDWOOD STANDS, U. S. Forest Serv. Northeast. Forest Expt. Sta., Sta. Paper 162, 22 pp., illus., 1961.

Table 2. — *Trend of sugar maple increase under tree-selection cutting in cove hardwood stands, expressed in average numbers of stems per acre*

Size class of stems	Original stands			5 years later[1]			10 years later[1]		
	Sugar maple	All commercial species	Percent sugar maple	Sugar maple	All commercial species	Percent sugar maple	Sugar maple	All commercial species	Percent sugar maple
	No.	*No.*	*%*	*No.*	*No.*	*%*	*No.*	*No.*	*%*
1 foot tall to 1 inch d.b.h.	848.0	1727.0	49.0	4193.0	7596.0	55.0	2649.0	5606.0	47.0
1 - 5 inches d.b.h.	146.0	391.0	37.0	155.0	329.0	47.0	178.0	414.0	43.0
6 inches d.b.h.	6.0	59.3	10.0	7.1	45.5	16.0	10.5	46.8	22.0
8 inches d.b.h.	2.1	38.4	5.5	2.6	29.2	8.9	3.5	27.9	12.5
10 inches d.b.h.	.9	29.4	3.1	.9	21.6	4.2	1.5	21.4	7.0
12 inches d.b.h.	.5	17.7	2.8	.5	16.7	3.0	.7	17.3	4.0

[1] Stands were cut after original measurements and were retallied 5 and 10 years later.

Beech, another intolerant, will also persist under selection management; but because it does not seed as prolifically as sugar maple, and because it will be discriminated against in marking on account of its generally poor form, beech will probably not become a very important component of future stands.

Sweet birch and red maple, which characteristically occur on these sites, will persist under tree-selection cutting.

The tolerant basswood and mid-tolerant white ash and hickory appear to do reasonably well under tree-selection systems. Because basswood and ash are desirable species, they will be favored in marking and will undoubtedly form a part of the future stands — perhaps as much as 20 percent.

The yellow-poplar, black cherry, and red oak that predominated at the beginning of the study period probably will shrink to less than 20 percent in the future all-aged stands.

A number of factors will influence the species proportions that will exist in the future on these good sites under all-aged silviculture. Among them are: species occurrence, as affected by topography, geography and past history; differences in site quality within the range of site conditions that support cove hardwoods; and differences in marking practices under the tree-selection system. However, in those parts of the Appalachian area where sugar maple commonly occurs, the stands resulting from continued tree-selection cutting will be composed more or less as follows:

Species	*Percent*
Sugar maple	50 - 75
Yellow-poplar, black cherry, red oak	5 - 20
Beech, sweet birch, red maple, basswood, ash, hickory	20 - 40
Others	5 - 10

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